Report #81-1-52
October 1981

BIOLOGICAL EVALUATION OF IPS BARK BEETLE INFESTATIONS ON CUMBERLAND ISLAND NATIONAL SEASHORE, GEORGIA

William A. Carothers
Terry S. Price
William H. Hoffard
Kerry G. Thomas
Gertrude Brandau

ABSTRACT

Infestations of pines by Ips spp. bark beetles are occurring on Cumberland Island National Seashore. Usually, infestations by these insects are of minimal concern on National Park Service areas, but populations could increase because of a wildfire which has killed or damaged pine trees on approximately 1,400 acres of the Island. Several direct and indirect control options are discussed.

INTRODUCTION

In response to a request by the Department of the Interior, National Park Service, a cooperative (Georgia Forestry Commission and USDA Forest Service, Forest Pest Management) evaluation team visited Cumberland Island National Seashore from August 24-26, 1981. The purpose of the visit was to conduct a biological evaluation of bark beetle infestations occurring on the Island.

Cumberland Island, one of many barrier islands off the coast of the Southeastern United States is located near the Georgia-Florida state line (Figure 1). The Island is approximately 20 miles long and averages 3 miles wide. Cumberland has a long and interesting history of human occupation and intensive use. As early as 2000 B.C., aboriginal tribes used the Island for hunting and habitation 1/. Spanish and English influence shaped the course of the Island's history. By 1768, nearly all of Cumberland Island had been granted to nine individuals. From 1786 until 1880, plantations produced live oak lumber, hogs, cattle, horses, citrus and other fruits, corn and other row crops, and most importantly, sea island cotton. After the Civil War, the economy of Cumberland Island declined, and the plantation lands with their magnificent homes were sold to wealthy individuals who use the Island as a recreational retreat. Eventually, some of these lands were purchased by the National Park Foundation. In 1972, Cumberland Island National Seashore became an official part of the National Park System. Today, the mixed federal and private ownership still remains.

1/ Information about the history and vegetation of Cumberland Island is taken from "The Ecology of the Cumberland Island National Seashore, Camden County, Georgia" by Hillestad, Bozeman, Johnson, Berisford, and Richardson.

Figure 1.--Location of Cumberland Island.

Four species of pine in six major communities of vegetation are found on Cumberland Island (Table 1): (1) Pinus palustris, longleaf pine, (2) Pinus elliottii, slash pine, (3) Pinus serotina, pond pine, and (4) Pinus taeda, loblolly pine. The significance of pine species as the dominant or co-dominant tree species of the major forest types is shown in Table 2. Pine is at least a minor component of the vegetation types on about 11,000 acres of the Island (Figure 2). All pine species present on the Island are susceptible to attack by Ips beetles.

Ips beetles life history

Ips beetles (or pine engraver beetles) belong to the family Scolytidae. They prefer to attack pines weakened by stress factors, such as soil compaction, storm damage, drought, and fire. Three common species of Ips occur in the South: Ips avulsus (about 2.5mm), Ips grandicollis (about 3.8mm), and Ips calligraphus (about 5.0mm). Ips prefer to attack material proportionate to their size with I. avulsus usually found in tree tops and smaller branches, I. grandicollis in the middle bole, and I. calligraphus nearer the tree base.

Polygamous male (mating with more than one female) beetles initiate attacks on the trees. If enough resin is present in the trees, pitch tubes (globs of resin and boring dust) form at the entry points (Figures 3a, 3b). In the absence of pitch, red boring dust is the only evidence of their entry (Figure 4). Once beneath the bark, males excavate nuptial chambers (mating chambers) and release a pheromone (sex attractant). Three to five females normally respond to the pheromone and fly to the attacked tree. After mating, females construct galleries radiating out from the nuptial chamber where they lay eggs between the bark and wood (Figure 5). These galleries normally run parallel with the wood grain. Typically, this pattern imparts a "Y" or "H" design on the wood surface and inner bark. Ips beetles also transmit the blue stain fungus, Ceratocystis minor, which helps kill the trees by plugging conductive tissues (Figure 6). Upon hatching, the wormlike larvae mine outward from the egg gallery and terminate their mines with pupal cells where they change to adults and emerge directly through the bark (Figures 7, 8). Trees from which Ips beetles have emerged appear as if shot with a scattergun.

There may be 6 to 10 or more generations per year depending on species, season, climate, and rainfall. Under optimum conditions for the insects, a generation can be completed in about three weeks.

Normally, Ips beetles pose little threat to healthy timber, but if a large volume of stressed timber is infested, heavy populations may develop and sometimes force successful attacks on adjacent, apparently vigorous trees. A lightning-caused wildfire began July 15, 1981 and burned approximately 1,400 acres on Cumberland Island (Figures 9a, 9b). As a result of this fire, many pines were killed or damaged. Because of the presence of existing Ips infestations and the trees damaged by the fire, observations were also made in fire-damaged areas.

Table 1.--Summary of principal vegetation types of Cumberland Island, Camden County, Georgia (Hillestad and others, n.d.)

Community Type	Composition
Dunes	Grass-Forb
	Dune-Shrub-Thicket
	Oak-Buckthorn-Scrub Forest
	Sand Beach
Interdune Flats	Grass-Sedge
	Interdune Shrub Thicket
	Pine-Mixed Hardwood
Salt Marsh	Grass (Spartina)
	Grass-Forb-Rush Marsh
	Shrub Border
	Oak-Juniper-Palm Forest
Fresh Water	Pond-Slough
	Grass-Sedge
	Shrub Marsh
	Lowland Mixed Hardwood Forest
Upland Forests	Mixed Oak-Hardwood
	Oak-Pine
	Oak-Palmetto
	Oak-Scrub
	Pine-Oak Scrub
Other Misc. Communities	Pasture and Lawns
	Cultivated Fields
	Pine Plantation

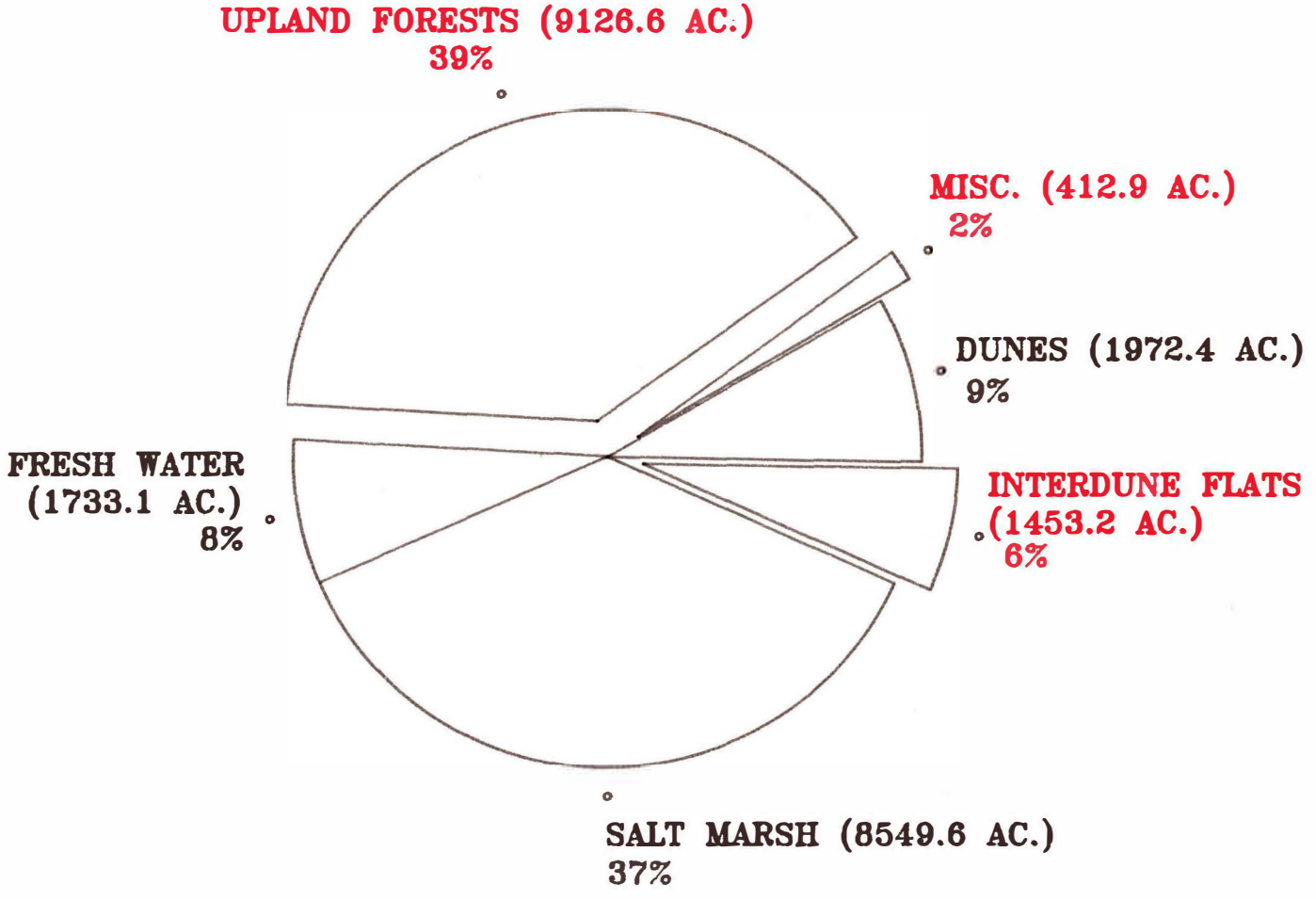
Table 2.--Summary of importance values for dominant and co-dominant tree species (> 4" dbh) composing the major forest types on Cumberland Island, Georgia (Hillestad and others, n.d.). Data based on 249 sample points, as determined by the point-quarter sampling method. Importance values of less than 10 are excluded. For specific meaning and interpretation of values, see appendix.

Species	Community Type						
	Pine-Oak Scrub (18) a	Oak Scrub (6)	Oak-Buckthorn Scrub (6)	Oak-Palmetto (59)	Oak-Pine (122)	Mixed oak-Hardwood (28)	Lowland Mixed Hardwood (10)
Pinus serotina*	77.0						
Pinus elliottii*	64.4	46.4	15.7		24.6		
Quercus myrtifolia		29.4					
Osmanthus americanus		14.9					
Quercus chapmanii		14.5					
Bumelia tenax			48.4				
Lyonia ferruginea	31.8		12.3	21.9		15.3	
Persea borbonia	28.8			31.3	15.5	14.9	
Quercus virginiana	79.9	194.7	197.9	192.8	118.1	118.4	77.3
Quercus laurifolia					36.7	47.7	
Pinus taeda*		13.6			28.2		41.4
Pinus palustris*					27.8	10.8	
Ilex opaca					12.9	21.8	
Juniperus silicicola					11.6	10.9	
Magnolia grandiflora						19.0	
Myrica cerifera		12.1					29.4
Persea palustris							65.6
Gordonia lasianthus							21.7
Magnolia virginiana							14.7
Quercus nigra							12.2
Acer rubrum							11.6

a Number in parentheses indicates number of sample points in each community type.

* Pine species.

FIGURE 2.--VEGETATION COVER TYPES OF CUMBERLAND ISLAND, GEORGIA.



SEPARATED SEGMENTS CONTAIN PINE

Figure 3a-Pitch tubes on attacked trees.

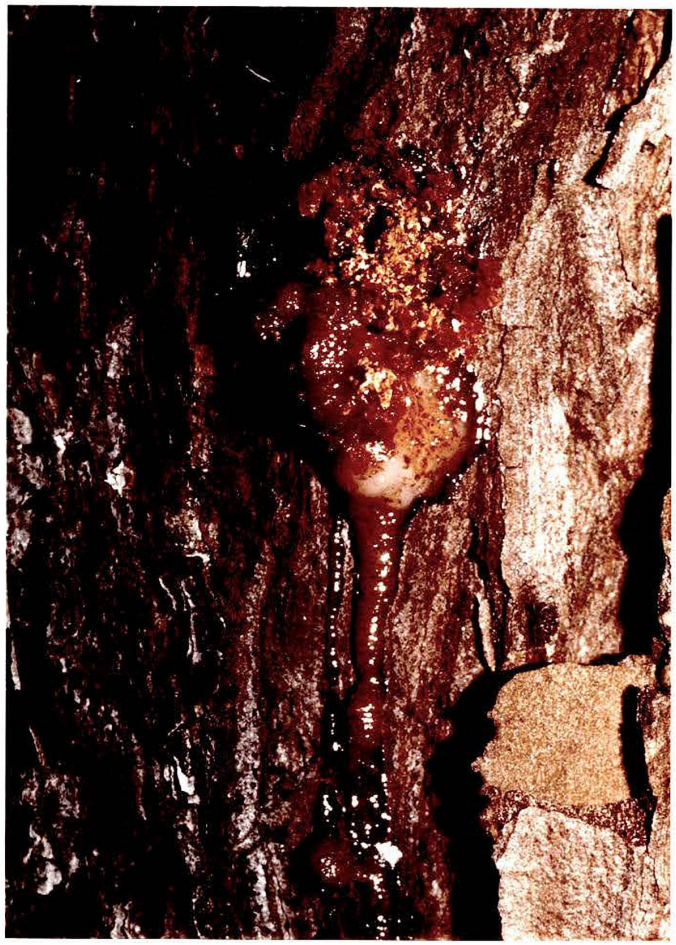


Figure 3b--Close-up of pitch tube showing resin and boring dust.

Figure 4.--Boring dust with a minimal amount of resin produced.

Figure 5.--Nuptial chamber with radiating galleries.

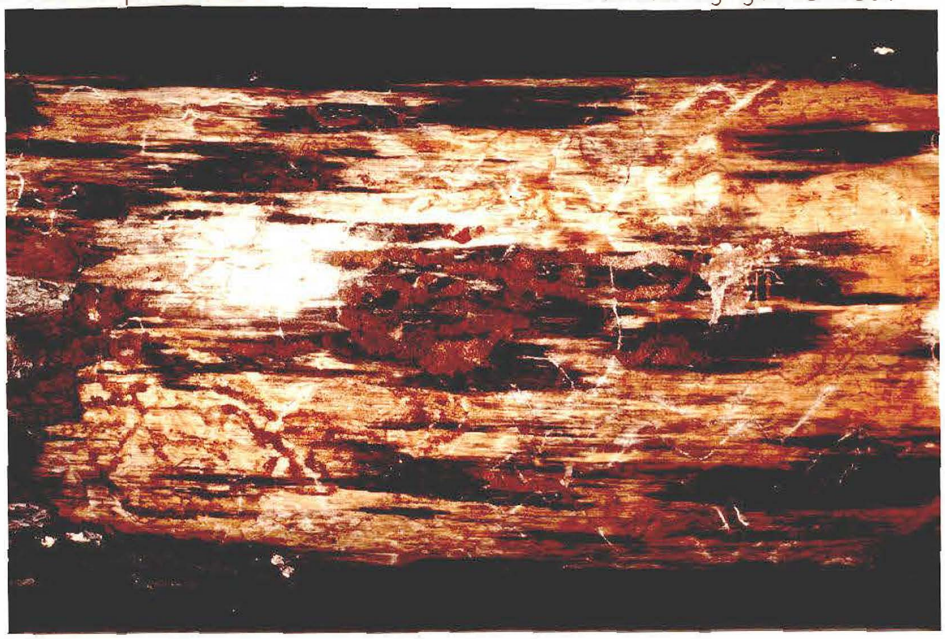


Figure 6.--The blue stain fungus, Ceratocystis minor, as it appears on the surface of the wood.

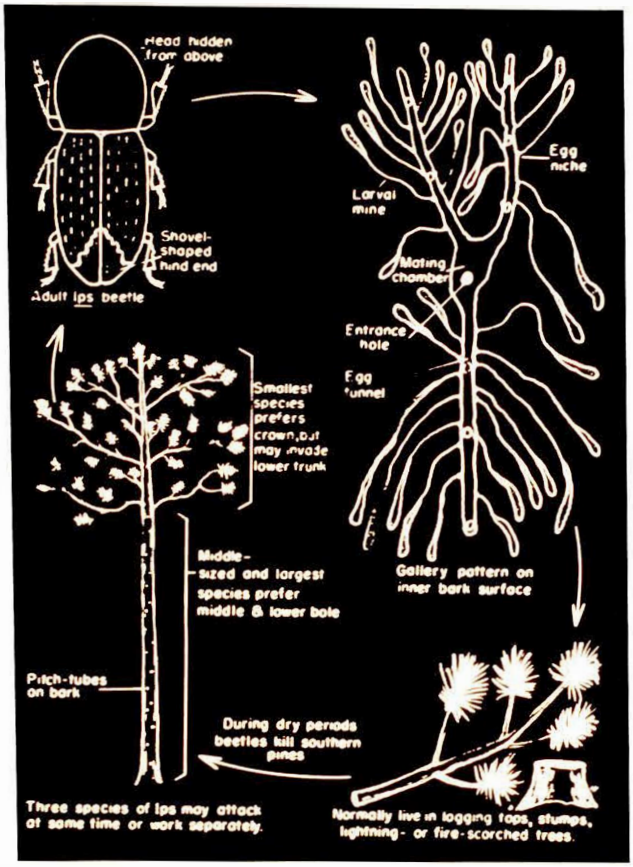


Figure 7.--Mode of attack and development of Ips beetles.

Figure 8.--Larval galleries and pupal cells.

Figure 9a--Aerial view of a portion of fire-damaged trees.

Figure 9b--Pines killed or stressed by fires.

METHODS

On August 5, 1981, the USDA Forest Service Aerial Survey Team acquired 100 percent aerial photographic coverage of Cumberland Island. The scale of the color infrared photography was 1:8000. The transparencies were interpreted to detect areas of pines which displayed off-color foliage. The locations of these areas were plotted on USGS 7.5 minute quadrangle topographic maps for ground-checking. From August 24-26, the cooperative evaluation team ground-checked 16 areas of dead and dying pines and recorded the cause of tree mortality. Ten areas within the boundaries of the July 15, 1981 wildfire were checked for the presence of Ips beetles.

RESULTS

In each of the 16 areas outside of the fire, Ips beetles were found infesting pines. Ips avulsus, I. grandicollis, and I. calligraphus were present, with I. calligraphus the predominant species. All of these infestations were associated with: (1) lightning struck trees, (2) trees which were mechanically wounded, (3) trees suffering from soil compaction, or (4) overmature trees. The number of trees per spot ranged from 1-24. Diameters ranged from 2 inches to 29 inches. The four species of pine found on Cumberland Island had been successfully attacked and killed by the beetles.

In eight of the ten areas located inside the boundary of the fire, Ips beetles were found infesting the dead or damaged pines. I. calligraphus was again the predominant species. Two sample areas on the northern perimeter of the fire did not show evidence of Ips beetle attacks. For the most part where the fire was hot enough to burn the crown of the tree or scorch more than 75 percent of the bole, Ips beetles were found infesting the damaged trees.

DISCUSSION

Ips beetles are native insects. In a totally natural forest setting, these insects act as natural thinning agents by eliminating diseased, damaged, or overmature trees from the forest. Ips beetles usually are not a problem except in areas where man's intrusion in the natural process of succession has altered the vegetation. Establishment of pine plantations, intensive agricultural practices, road cutting, building site development, and protection of lands from wildfire are but a few of the many practices that alter successional development. Cumberland Island has many such disturbed areas. The Ips infestations existing outside of the fire area are a result of man-caused or natural tree stress. The origins of the infestations in the burned area are in all probability similar to those of the infestations outside the burned area. Soil compaction, drought, lightning strikes, and other stressful conditions discussed previously were present in the area before the fire. Ips infestations were also present before the fire as evidenced by groups of trees killed before the fire occurred. Again, these infestations were part of the natural system.

Because of such variables as topography, water levels, fuel load, and so on, not all trees in the burned area were killed outright. Epicormic branching, a response to severe damage or death of the cambium, is evident in many of these pines (Figure 10). Many of these trees will become infested by Ips

Figure 10.--Epicormic branching.

beetles, particularly around the perimeter of the burned area. No doubt, additional healthy trees will also be infested as the population increases in fire-damaged pines. It is difficult, however, to predict which or how many healthy trees will be attacked and killed. Many factors will help to determine the increase or decline in the Ips population level. Dry, warm weather is advantageous for the beetles, whereas wet, cold weather might work against a population buildup.

Lightning-struck, overmature, otherwise stressed pines are part of the natural system of the developing forest community on Cumberland Island. As long as stress agents, whether man-caused or natural, affect the trees, Ips beetle infestations will occur.

RECOMMENDATIONS

Below are listed viable options for dealing with Ips infestations on Cumberland Island. All are in accordance with National Park Service management policies.

A. Direct Control Options

1. Pile and burn infested trees

All trees should be felled toward the center of the infestation. Tree boles, as well as slash and any infested bark, should be piled in a central area away from uninfested pines and burned until the bark is well charred.

2. Solar radiation exposure

For use when the average daytime temperature is 80° or greater.

a. Direct exposure method - all infested trees should be felled with the boles in a north-south orientation and spread out for optimum exposure to direct sunlight. The trees should be turned after five days so that all surfaces receive exposure to direct sunlight. This method results in a significant buildup of heat beneath the bark, which destroys developing beetle brood.

b. Greenhouse effect method - all infested trees should be felled toward the center of the infestation. Trees may be bucked, piled along with the tops, and then covered by heavy gauge clear polyethylene sheeting. The sheeting should be of sufficient gauge to resist tearing and should be securely anchored to the ground. The plastic traps and holds the heat, which kills the developing brood. Polyethylene sheeting should remain intact for 30 days (Buffam, 1968).

3. Debarking

Trees should be felled and debarked. All bark should be burned to insure destruction of any remaining brood.

B. Indirect Control Options

In addition to the direct control methods listed above, several preventative measures will help minimize Ips population buildups.

1. Minimize damage to trees and site.

Trees under stress are attractive to Ips beetles. In using heavy equipment for road maintenance or building site construction, use care to minimize root damage and soil compaction.

2. Scatter breeding material during clearing operations.

In addition to breeding in stressed trees, Ips beetles reproduce in the slash from clearing operations. Scattering of the slash promotes rapid desiccation of the tops and limbs, making them unsuitable for beetle breeding purposes. Bolts cut from infested or uninfested trees should not be stacked against or near uninfested trees. The resinous odors may attract beetles resulting in the establishment of a new infestation.

3. Do not conduct clearing operations during periods of extreme tree stress.

A certain amount of *Ips* population buildup in slash is almost inevitable. If clearing operations are conducted when trees are stressed (drought, flooding, etc.), residual trees may be attacked and killed as a result.

C. No Control

Under this option, infestations would be allowed to run their natural course until brought under control by parasites, predators, weather, or lack of suitable host material. The disadvantage of this option is that the possibility of additional tree loss exists, before natural control of the infestation occurs. Advantages include: (1) no cost, and (2) no artificial disruption of the environment.

We suggest that Control Option C be used within the boundaries of the fire area. Direct Control Options applied in the fire area would be economically unreasonable and biologically ineffective because of the number of dead and damaged trees. Around the periphery or outside of the fire area, any of the Direct Control Options would be justified for use in controlling *Ips* bark beetle infestations.

Timber is not a commercial crop on either the federal or private land of Cumberland Island. Pines are little used as ornamental or landscape trees on the Island. Nonetheless, the four species of pine present play important roles in the make-up of the Island vegetation cover. Trees killed by insects, diseases, fire, or other factors that pose a threat to visitors, inhabitants, or facilities should be considered hazardous and treated appropriately. Field surveillance by National Park Service personnel should continue to facilitate early detection of potential insect or disease problems. The USDA Forest Service, Forest Pest Management group will conduct an aerial survey of Cumberland Island National Seashore within the next three months to further monitor the current *Ips* infestations.

ACKNOWLEDGEMENT

The members of the cooperative evaluation team thank the National Park Service personnel at Cumberland Island National Seashore for their hospitality and assistance in conducting this evaluation.

Appendix

Methods of Vegetation Analysis (see Table 2)
(from Hillestad and others, n.d.)

This survey was initiated in November 1972 and continued to September of 1973. Preliminary studies involved reconnaissance surveys, consultation with area soil scientists, and examination of aerial photographs, topographic maps, and old land use maps. These preliminary studies provided a good understanding of the plant-soil interrelationships, effects of land use practices on vegetation, and the physical features of the Island. Quantitative measurements of vegetation and collection of voucher specimens for the compilation of the plant catalog were conducted primarily during the summer months of June, July, and August, when the investigators were in residence on the Island.

Quantitative measurements of the interior vegetation of the Island were made using a variation of the quarter-point or point-quarter method established by Cottam and Curtis (1956). Sample points were located along all accessible roads at pre-determined 0.2-mile intervals. At each interval, a point was alternately selected for each side of the road at a distance of 100 feet, as measured by pacing at right angles from the center of the road. By this procedure, 249 points were sampled for trees equal to or greater than 4 inches in diameter at breast height. At each point, the closest tree to the point in each of four quarters was chosen. The species, stem diameter, and distance to the point were recorded for the sample tree in each quarter. The presence of woody understory species, including saplings and seedlings of tree species less than 4 inches in diameter, was recorded for 250 6.6- x 6.6-foot quadrats centered on each point. Similarly, the presence of herbaceous ground cover species was recorded for 248 3.3- x 3.3-foot quadrats located in the right front quadrat of each point. A continuous log of variations in topography, drainage features, and plant community composition was maintained between each sample point. By these procedures, qualitative descriptions and quantitative measurements were obtained for approximately 50 linear miles of the vegetation on the Island interior.

Qualitative measurements of the beach, dune, and interdune vegetation were made along 10 transect lines that traversed these habitats perpendicular to the shoreline. The transect sites were selected by first dividing the 16-mile long shoreline into 2-mile intervals; second, by dividing each 2-mile interval into tenths; and, third, by choosing a tenth-interval from zero to 20 from a random numbers table. In this manner, one transect was randomly selected from each 2-mile interval. Two additional transects were randomly selected by choosing a tenth-interval from one to 160 from a random numbers table. The jetty on the south end of the Island was used as a reference point for the location of transects. Beginning with zero miles at the jetty (a permanent structure), all transect locations were measured by odometer and marked by metal stakes and tags for future reference. Each transect was started at a point corresponding to the high tide drift line.

The presence of herbaceous and woody species and of bare and disturbed areas was recorded for 3.3- x 3.3-foot quadrats located at 30-foot intervals along these transect lines. A total of 151 quadrats were analyzed in this manner. Notes on changes in elevation, slope, exposure, and moisture conditions were compiled for each transect for future reference.

Synthesis of the quadrat data of the dune and interdune habitats was begun by subdividing these areas into several categories based on exposure, slope, and wetness. The data were tabulated accordingly, then consolidated into the following habitat-communities: foredunes, interdune high meadow, interdune low meadow (wet), interdune shrub thicket, rear dune, and unstable dune. By vertical movement and manipulation of species in the table according to frequency and distribution, it was possible to demonstrate the composition of communities occupying these habitats along a complex environment gradient from foredune to reardune.

LITERATURE CITED

Baker, Whitefore L. Eastern Forest Insects. Misc. Pub. 1175. USDA Forest Service, 1972. 642 p.

Buffam, P. E. and D. D. Lucht. Use of polyethylene sheeting for control of Ips spp. in logging debris. J. Econ. Entomol. 61(5): 1465-1466, 1968.

Cottam, G. and J. T. Curtis. The use of distance measures in phytosociological sampling. Ecology 37(3): 451-460, 1956.

Hillestad, Hilburn O., J. R. Bozeman, A. S. Johnson, C. W. Berisford, and J. D. Richardson. The Ecology of Cumberland Island National Seashore, Camden County, Georgia (n.d.). Technical Report Series 75-5.